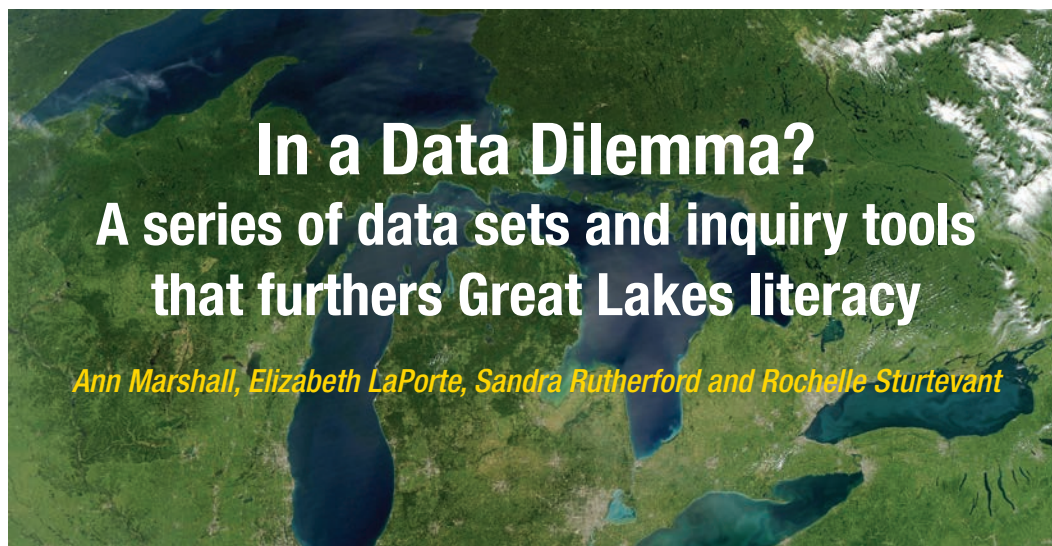


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## Abstract

Using real data in science classrooms is a powerful way to encourage inquiry and teach process skills. However, many educators have found geoscience data difficult to access and use. As part of a NOAA Environmental Literacy Grant, the *Teaching with Great Lakes Data* website ([www.greatlakeslessons.com](http://www.greatlakeslessons.com)) was developed using scientific data about the Great Lakes. This online resource contains data sets formatted for use by teachers, as well as structured lessons and tools for graphing and guided inquiry.

Looking for real data and inquiry tools for your Earth Science or Biology classroom? The *Teaching with Great Lakes Data* website focuses on expanding knowledge about Great Lakes science content, through the use of real data. The website has data sets of dissolved oxygen, temperature, *E. coli*, and more. There are also structured lessons for younger grades and more open guided inquiry methods for the older grades to use.

One challenge that science teachers have is finding data for lesson planning which teaches students graphing skills and helps them with interpretation, two skills that are important in science. While there is a lot of geoscience data out there, it is rarely classroom-ready. Most of it is compiled for scientific research purposes with no thought to possible classroom use and it does not always engage students in a meaningful way (Ledley et al., 2008). Even when the data is suitable for classroom use, teachers may lack the time to develop lessons and classroom activities that incorporate the data.

Unlike a cookbook lab, real data does not always produce a smooth curve on a graph. Students can practice many process skills by graphing and analyzing real data. Therefore, it is important for students to use real data when investigating a question or problem. As part of a National Oceanic and Atmospheric Administration (NOAA) Environmental Literacy Grant, the *Teaching with Great Lakes Data* website ([www.greatlakeslessons.com](http://www.greatlakeslessons.com)) was developed in partnership with Michigan Sea Grant using Great Lakes scientific data from the Great Lakes Environmental Research Laboratory (GLERL), the U.S. Geological Survey, and other sources.

## Teaching With Great Lakes Data Website

Today, school districts are faced with limited budgets and often lack funding to allow students to go on field studies. This limitation can be addressed by providing educators with tools to incorporate experiential elements into the classroom. Teachers can help students connect to scientific data sets and promote inquiry-based learning through the *Teaching with Great Lakes Data* web portal. A

collaborative relationship among Eastern Michigan University (EMU), Michigan Sea Grant (<http://www.miseagrant.umich.edu>), the National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Laboratory (NOAA-GLERL, [www.glerl.noaa.gov](http://www.glerl.noaa.gov)), the Center for Ocean Science Education Excellence- Great Lakes (COSEE-Great Lakes (<http://coseegreatlakes.net>) and the Great Lakes Observing System (GLOS, <http://glos.us>) was forged to develop a web portal with data sets, inquiry and assessment tools, lessons and activities. COSEE-Great Lakes and GLOS facilitated workshops to orient teachers to the website's resources. The last workshop was held in the spring 2012. Michigan Sea Grant is hoping to secure new grant funds to do more work with *Teaching with Great Lakes Data*.

The web portal (Figure 1) was structured to make guided learning activities easy to navigate and implement in the classroom. The main content areas on the website are structured lesson activities, data sets, inquiry tools, and resources.



**Figure 1.** Header from the Teaching with Great Lakes Data website.

## Great Lakes Water Data Sets, Lessons, and Activities

The majority of the data for this website has been compiled by scientists at NOAA-GLERL. Data were gathered from buoys, satellites and other monitoring devices as part of a regional and global monitoring effort. NOAA-GLERL has both historical and real-time data available. However, the format of the data was not originally ideal for educational purposes. Pre-service teachers from Eastern Michigan University worked with NOAA-GLERL scientists to extract and modify the data sets that research scientists provided. Data was transferred to a spreadsheet format. Subsets were extracted from large data sets to increase accessibility, specifically for grade 5-12 educators and students.

The data sets and lesson materials are provided in four main modules: Earth Science, Physical Science, Life Science, and Social Science. The modules contain data sets and resources about Great Lakes facts, temperature, precipitation, water level, water flow, dissolved oxygen, secchi depth (a measure of water clarity), light levels, turbidity, specific conductivity, pH levels, chlorophyll levels, and phosphorus levels. There are also data sets and resources about populations of plankton, algae, invasive mussels and fishes, fish habitat, and the impact of ballast water from ships. The abundance of out-migrating Chinook salmon smolts, sampling of three forage fish species and commercial and recreational fish harvests is included. Finally, there are data sets and resources about the poor health of some beaches including the impacts of harmful algal blooms, *E. coli* concentrations, beach litter, and toxin levels in fish.

**Figure 2.** Background information and pictures (like this secchi disk) help the student and the teacher understand the data.

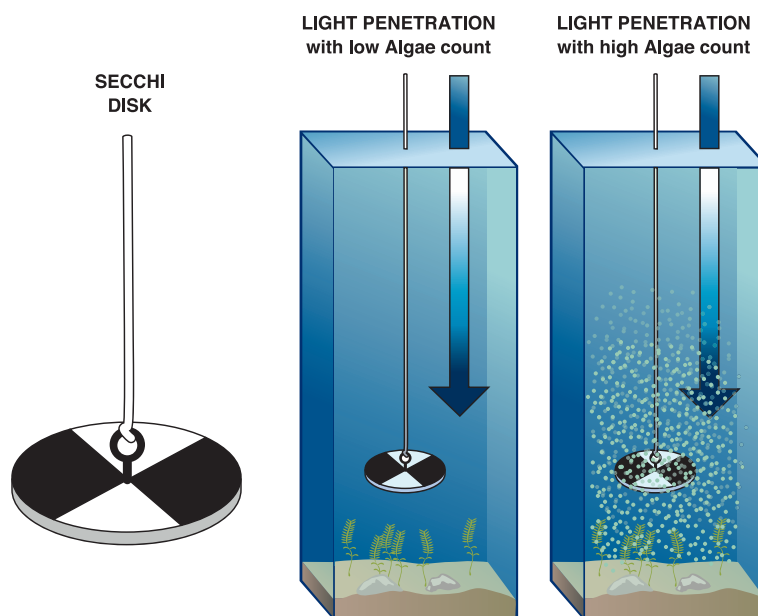
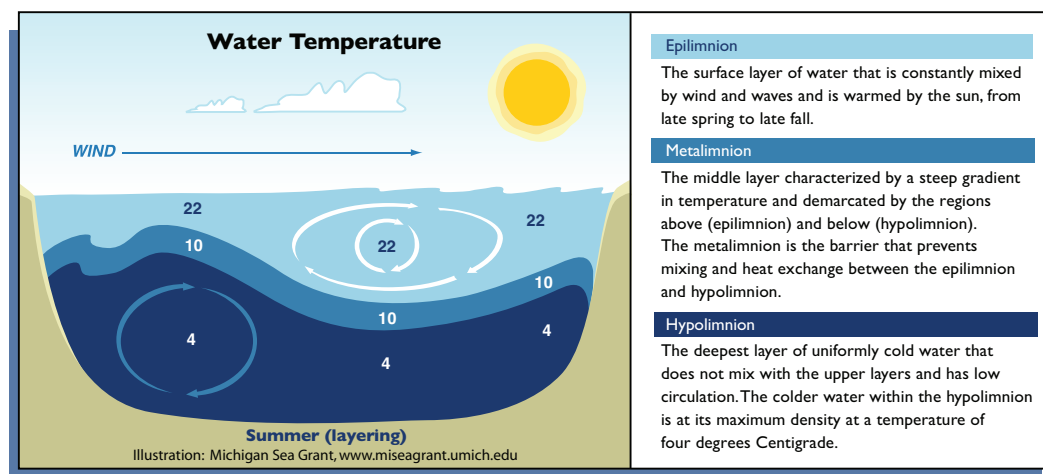


Illustration: Michigan Sea Grant

Each data set is linked from a main web page. This page (see example in Figure 2) includes a link to the data set, a summary of the data set and sample inquiry questions. Also included is background material that provides an outline of the data set, the concepts surrounding the data, calculations that were provided in the data, a map of where the data were collected (if available), the purpose and methods of the research, graphics, still pictures, fact sheets, and videos (if available). The background section also provides topical information (e.g., water quality), suggestions of how the

data can be used and how data sets can be compared with each other or used together, and links to additional information.

The structured lessons and activities on this website are fully developed and ready-to-use (Figure 3). The lesson topics are: dead zones, fisheries, storm surges, and climate and weather. They are aligned for grades 5-8; however, these lessons can be adapted for



**Figure 3.** Great Lakes lesson about Dead Zones.

From the Teaching with Great Lakes website.

use by high school teachers. Included in each lesson is background information on broad scientific concepts and hands-on learning activities. Each lesson comes complete with the lesson plan, downloadable materials needed for the lesson, as well as standards and assessment tools. All of the lessons have been aligned to the national science standards (NRC, 1996) and with the Great Lakes Literacy Principles (<http://greatlakesliteracy.net/>).

## Inquiry Tools and Resources

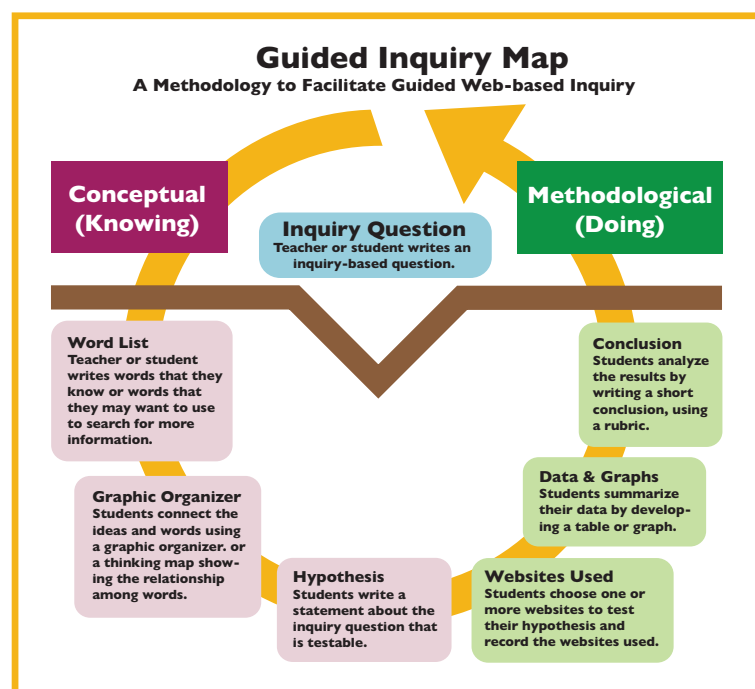
Ledley et al. (2008) suggest that students should learn science through inquiry and one way to engage students in scientific inquiry is to offer the data and analysis tools they need to investigate concepts and answer questions. The nature of science as a process can sometimes be a hard concept to grasp, as many students approach science by trying to find the answer to a question. But often times, there is no direct answer or solution to scientific issues, only more questions. Students also have a hard time designing and conducting a scientific investigation, and many feel that using data that are supplied to them is not “doing” science. However, scientific investigations can take many forms and multiple approaches. The process is not linear and is flexible in nature. According to the Biological Sciences Curriculum Study’s (BSCS) Center for Curriculum Development (2005), students often associate science with experimentation, yet “science also uses observations, surveys, and other non-experimental approaches.”

Another challenge students have is generating a question for scientific investigations that is “testable”. In order for a question to be testable, it has to meet certain criteria. First and foremost, the question must use data; therefore the content of the question must have variables. A scoring rubric for evaluating a testable question was objectively developed by Graves and Rutherford (2012). It was designed to evaluate the students’ ability to identify measureable variables, state specific parameters for the investigation, identify potential relationships between the variables, and communicate their analysis. Graves and Rutherford (2012) present examples of exemplar testable questions and non-testable questions. One example of an exemplary question is “Do the **water surface temperatures** differ for **1950 and 1960** in Lake Superior from January to June?” Note that the variables are highlighted.



The Virtual Vee Map (Figure 4) is a guided inquiry method to assist grade 5-12 teachers in aiming for higher level thinking and science process skills for their students (Coffman and Riggs, 2006). The *Teaching with Great Lakes Data* website provides a step-by-step explanation of the Virtual Vee Map methodology and includes the tools to implement this project (data sets, templates, diagrams and a rubric). By providing real-world data in a classroom-friendly format, the guided inquiry Virtual Vee Map provides teachers with a tool that can help drive their students to summarize knowledge, analyze data and evaluate findings. This method is especially useful for high school but an adept grade 5 teacher could also use this technique.

The process for using the Virtual Vee Map is simple for both the teacher and the student-scientist. Teachers have flexibility in how involved they want to be in the student investigation process. The activity can be completely teacher-directed or totally student-directed, or guided to varying degrees by the teacher. Teachers support student-scientists who decide on an inquiry question and describe the known concepts that support their investigation. Students record the events that occur during their investigations of data sets and analyze how to represent this new information. Finally, students interpret new information in light of the known concepts and their inquiry question; and then summarize their findings.



**Figure 4.** Summary of the inquiry process of the Virtual Vee Map methodology.

From the *Teaching with Great Lakes* website.

## Perspectives from the Classroom

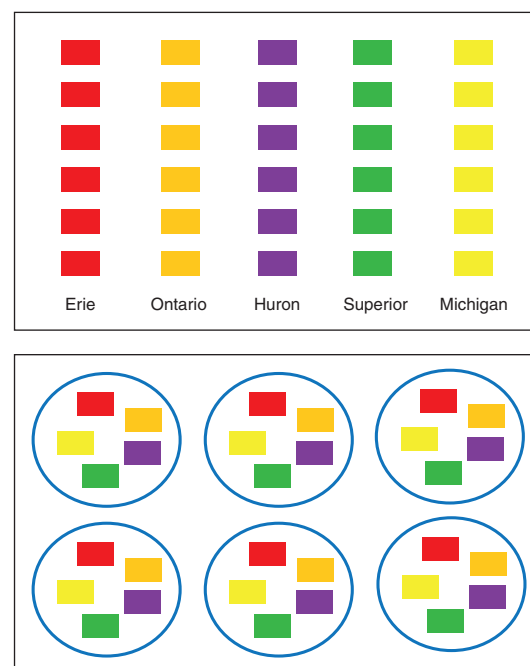
Lyndsey Manzo who teaches at Westerville North High School in Ohio suggested one way to use the *Teaching with Great Lakes Data* website in the classroom. Using the Temperature and Precipitation data set she recommended doing a jigsaw exercise whereby the students work in multiple groups. The students are grouped by lake: Lake Erie, Lake Superior etc. In a class with 30 students, there would be five groups, each with six students (Figure 5). The students in each group become experts on their specific lake.

After the Specific Lake Expert (A) groups have looked at the data, and graphed the water surface temperature for their lake, they are put into new groups (Figure 6). These Lake Comparison (B) groups are where the students share what they discovered about their lake, look for patterns and predict future trends. This jigsaw exercise is just one way that teachers can use the data sets on the website.

## Conclusion

The *Teaching with Great Lakes Data* website helps solve the data dilemma for teachers because both data and inquiry tools are available on the website.

Eidietis et al. (2010) found that very few teachers use online resources about the Great Lakes in lesson planning or classroom activities because they often do not know about them. They also determined that those teachers who are shown these resources during professional development or in pre-service courses were more likely to use them in their own classroom. Workshops for teachers



**Figure 5.** (top) Specific Lake Expert (A) Groups

**Figure 6.** (bottom) Lake Comparison (B) Groups

have been conducted to inform teachers about the data sets and familiarize them with the activities available on this website. The teachers have the opportunity to actually do these activities at the workshop thus they feel comfortable doing them in their own classrooms. Previous professional development has resolved the problem that Eidietis et al. (2010) exposed. All in all, the web portal is a great resource that educators, both near and far from the Great Lakes, can use to allow students to make authentic, real-world connections.

## Acknowledgements

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## INSIDE THIS ISSUE

From the President . . . . .	2
From the Executive Director . . . . .	3
Editor's Corner . . . . .	5
In a Data Dilemma? A series of data sets and inquiry tools that furthers Great Lakes literacy . . . . .	6
C-MORE Professional Development Training Program for Graduate Students and Post-Doctoral Researchers . . . . .	11
Mapping Our World – Celebrate Earth Science Week 2013 . . . . .	17
GeoSTEM: Establishing a Geoscience and Remote Sensing Laboratory . . . . .	19
Challenge: Sequencing – Using Spatial Relationships to Understand Temporal Patterns. . . . .	24
First Wave: GeoFORCE Texas Students Graduate from College . . . . .	30
Advertising in The Earth Scientist . . . . .	34
Manuscript Guidelines . . . . .	35

*This image of Turkey Run Covered Bridge was shot in Oct. 2010 at Turkey Run State Park, in Indiana by Jay Brooks during a trip to photograph their many covered bridges and capture fall color. This image was captured with a Canon 7D camera with a 10-22 wide angle lens, aperture priority, F16, 13mm, 400 iso, and processed in Lightroom.*

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